Chapter 4

PHOTOGRAPHIC LIGHT FILTERS

Photographic Light Filters. Photographic light filters may be divided into four classes: (1) color filters, (2) viewing filters, (3) neutral density filters, and (4) polarizing filters. *Color* filters are used to control the relative tone values in which colors are rendered by the photographic process; i.e., to lighten or darken particular colors or to obtain color-separation records for color photography. *Viewing* filters are designed to show by direct observation the relative values in which colors will be reproduced by a particular type of sensitive material without or with a given filter. *Neutral density* filters are used to reduce the light intensity to prevent overexposure. In professional motion picture photography, for example, the use of neutral density filters on desert scenes, views over water, etc., enables these subjects to be photographed at the same lens aperture as the other scenes in the film so as to avoid any change in depth of field or image characteristics. In amateur cinematography, neutral density filters may be necessary, with certain cameras, to prevent overexposure on strongly illuminated subjects when high-speed negative materials are used. Neutral density filters are used in tricolor cameras to obtain equal exposures on the three negatives. *Polarizing* filters are used primarily to control light reflected from highly polished surfaces, metallic objects, etc., to photograph through glass and to darken the sky in color photography where a color filter cannot be used.

Color Filters. A color filter may be defined as an optically homogeneous (i.e., nondiffusing) medium in which the absorption of light (and therefore the transmission) varies with the wave length. The curve in Fig. 4.1 represents the relation between absorption and wave length of a common yellow filter. The portion above represents the transmission in relation to wave length

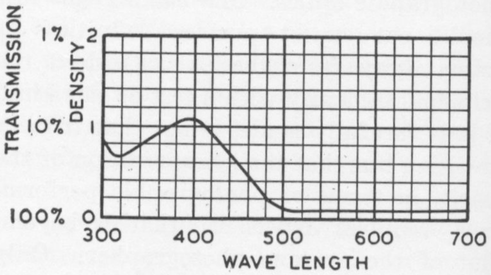

FIG. 4.1. Spectrophotometric curve of a yellow filter (Wratten No. 6, K_1).

$$T = \frac{I_0}{I_x}$$

where I_0 is the illumination incident on the filter, and I_x is the intensity of the illumination emerging. For convenience, the value of I_0/I_x is usually multiplied by 100 so that that the transmission is expressed as a percentage. The dark portion represents the relation between absorption and wave length in terms of *density*

$$D = \log \frac{I}{T} \quad \text{or} \quad \log_{10} \frac{I}{I}.$$

Curves of this type are determined by means of measurements made in a spectrophotometer which is an instrument for

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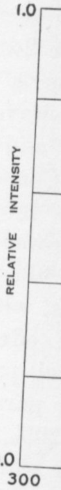

FIG. 4.2.
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two dyed gelatin fil
only necessary to ac
the density values
spectrophotometer [2]

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[1] Barton, A Textbook
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[2] Spectrophotometric
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Filters published by the
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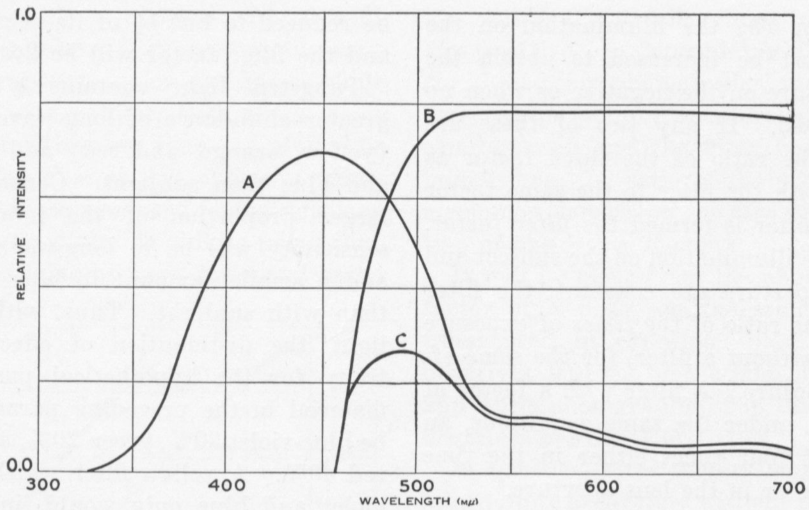

FIG. 4.2. Curves representing (a) the spectral sensitivity of a particular panchromatic emulsion, (b) the transmission curve of a yellow filter, and (c) the distribution of sensitivity with the filter.

making comparisons of light intensity in different parts of the spectrum.[1]

The absorption curve, in which density is plotted as a function of wave length, is more convenient than the transmission curve for calculations of (1) the effect of the dye concentration on the spectral absorption characteristics of the filter, (2) the absorption characteristics of a mixture of two or more dyes, or (3) the result obtained by superimposing filters. Thus to compute the curve for two dyes used together, or if certain corrections are made, two dyed gelatin filters superimposed, it is only necessary to add at each wave length the density values as determined in the spectrophotometer [2] in terms of I_0/I_x.

The effect of a filter on the distribution of sensitivity for a particular photographic material may be found by multiplying, wave length by wave length, the ordinates of the curve representing the spectral response of the emulsion by those of the curve representing the transmission of the filter. In Fig. 4.2, for example, curve *A* represents the spectral sensitivity of a panchromatic material, *B* is the transmission curve of a yellow filter plotted on the same basis. By multiplying the ordinates of curve *A* by those of curve *B* at corresponding wave length, curve *C* representing the distribution of sensitivity of the film with the filter is obtained.

Filter Factors. When a filter is used which absorbs some of the radiation to which the photographic material is sensitive, (1) the exposure time, (2) the lens

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[1] Barton, A Textbook on Light, Longmans Green and Co., New York, 1939. Jacobs, *Fundamentals of Optical Engineering,* McGraw-Hill Book Co., New York.

[2] Spectrophotometric curves of more than 100 dyed gelatin filters will be found in Wratten Light Filters published by the Eastman Kodak Company, Rochester, N. Y. (1948).

The absorption of filters is frequently represented by wedge spectrograms. While useful for comparative purposes, wedge spectrograms necessarily represent filter characteristics in terms of some particular light source and photographic material.

Photographic Filter Terminology and Nomenclature. ASA Standard Z52.61–1945.